

### **REMARKS**

Applicants and their representatives thank the Examiner for the courtesy of a telephone interview conducted on June 10, 2009. Applicants' representative also thanks the Examiner for a second telephone interview conducted on July 29, 2009.

During the June 10, 2009 interview, the Koch and Horita references were discussed. During the July 29, 2009 interview, the Examiner noted that her Supervising Examiner, Dah-Wei Yuan, believed that the claims were not allowable because of two additional references, Phelps and Redey. Each of these are discussed in detail below. Accordingly, the present response is believed to constitute a complete written statement of the reasons presented in the respective interviews as wanting favorable action, as required by 37 C.F.R. §1.133.

Claims 116-120, 123-131, 133-140, and 142-145 remain pending for examination. No amendments have been made to the claims.

#### **Rejection under 35 U.S.C. §103(a)**

Claims 116-120, 123-132, 135-141, 144 and 145 have been rejected under 35 U.S.C. §103(a) as being unpatentable over Koch, German Patent No. DE 4004220 C1 ("Koch") in view of UK Patent No. GB 2,278,010 ("Horita" or "Teruhisa"). These references were the subject of the June 10, 2009 interview with Tani Chen, Tao "Tom" Tao (the first-named inventor of the instant application), and Jeff Bently (representing CellTech Power, the assignee of the instant application). As discussed during the interview, it is not seen how either Koch or Horita, alone or in combination, teaches or suggests a solid-state electrolyte in combination with an anode wherein at least a portion of the anode is liquid, as is recited in the claims as pending.

In the interview, Koch was initially discussed. The device of Koch, like most fuel cells, works by causing a chemical reaction in which electrons and ions are separated from each other, where the electrons are harnessed to do useful work (in the physics sense). In the cathode compartment, O<sub>2</sub> (oxygen gas) reacts with tin to produce SnO<sub>2</sub> (tin oxide), while in the anode compartment, fuel reacts with the oxygen from the SnO<sub>2</sub> to produce electrons, CO<sub>2</sub>, and other by-products. Accordingly, the net result of the reactions occurring in both the anode and cathode

compartments is that fuel is reacted with  $O_2$  to produce  $CO_2$ , other by-products, and a flow of electrons (i.e., current).

The electrolyte separates the anode compartment from the cathode compartment within the fuel cell. In addition, the electrolyte prevents any electron transport from occurring through the electrolyte, while simultaneously allowing oxygen to cross. Since electron transport across the electrolyte is prevented, electrons instead are transported via an electrically conductive pathway in electrical communication with the anodic and cathodic electrodes, in the process being harnessed to perform useful work.

Koch describes an electrolyte formed from molten carbonate, containing  $Na_2CO_3$  (sodium carbonate) and  $Li_2CO_3$  (lithium carbonate), as discussed on p. 5 of the English translation of Koch. The electrolyte separates the anode compartment from the cathode compartment. Within the molten carbonate electrolyte, dissolved  $SnO_2$  is used to carry oxygen across the electrolyte. Accordingly, within the anode compartment,  $Sn^0$  (liquid metal tin) reacts with  $O_2$  to produce  $SnO_2$  and electrons. See p. 6 and Fig. 1 of Koch. After being transported across the electrolyte from the anode compartment to the cathode compartment, the  $SnO_2$  reacts with fuel and electrons in the cathode compartment to produce  $CO_2$  and  $Sn^0$  (liquid metal tin). The liquid metal tin, being denser than the molten carbonate, falls back through the molten carbonate to the anode compartment, and the cycle repeats. Accordingly, the net result is that oxygen is transported through the molten electrolyte layer from the anode compartment to the cathode compartment in the form of  $SnO_2$ .

The reason Koch uses a molten carbonate electrolyte is that  $SnO_2$  is actually a solid at temperatures at which the device of Koch is used (approximately  $900^\circ C$ , see p. 5, paragraph 1). (The melting point of  $SnO_2$  is actually about  $1630^\circ C$ .) Accordingly, to use  $SnO_2$  as a carrier for oxygen, it must be moved from the anode compartment to the cathode compartment, and for that reason, it must be in a fluidic state, either by heating it up until it becomes a liquid, or dissolving it within another liquid (as Koch does). If the electrolyte were a solid, then  $SnO_2$  could not be transported across the electrolyte—as a solid cannot move within another solid. Thus, Koch in no way discloses or suggests a solid electrolyte; such a modification would render Koch inoperative for its intended purpose.

Horita on the other hand, while disclosing a solid-state zirconium oxide electrolyte, is directed to a solid oxide fuel cell, not a molten carbonate fuel cell. Solid oxide fuel cells are not interchangeable with molten carbonate fuel cells, as the chemical reactions that convert fuel into electron current and CO<sub>2</sub> are quite different. In Horita, oxygen diffuses across the solid-state zirconium oxide electrolyte as O<sup>2-</sup>—not as SnO<sub>2</sub>—and the O<sup>2-</sup> reacts with vanadium carbide (VC) to produce various vanadium oxides (VO<sub>x</sub>), CO or CO<sub>2</sub>, and electrons. In particular, it should be noted that this reaction occurs due to the reaction of VC with the oxide ions, i.e.:



See, e.g., p. 12, lines 15-24 of Horita. Because this reaction relies on the reaction between VC and O<sup>2-</sup>, one could not replace the O<sup>2-</sup> with SnO<sub>2</sub> and still expect a chemical reaction to occur. VC is not known to be reactive with SnO<sub>2</sub>, and fuel cells work *because* of the close chemical interplay between the chemical reactions occurring in the anode compartment that generate oxygen (as O<sup>2-</sup> or SnO<sub>2</sub>), and the electrolyte in contact with the anode compartment that transports the oxygen across to the cathode. Accordingly, one cannot substitute a molten carbonate electrolyte (used to transport SnO<sub>2</sub>) with a solid zirconium oxide electrolyte (used to transport O<sup>2-</sup>) with a reasonable expectation of success. These are not recognized in the art as being interchangeable.

Accordingly, it is believed that the combination of Koch and Teruhisa is improper, and it is accordingly respectfully requested that this rejection be withdrawn.

#### Additional References

In the subsequent July 29, 2009 interview, the Examiner had raised two additional references, Phelps, U.S. Patent No. 6,120,933 (“Phelps”), and Redey, *et al.*, U.S. Patent No. 6,379,844 (“Redey”).

At the outset, Applicants were not previously aware of Redey, although the Applicants had been previously been aware of Phelps, and have cited Phelps in an Information Disclosure Statement that was acknowledged by the Examiner. Thus, as this is the first instance of Redey being cited, and as the Examiner is the one who first raised Redey, it is accordingly respectfully

requested that the Examiner also provide a PTO-892 form that acknowledges the fact that she considered Redey as a reference.

In the July 29, 2009 interview, the Examiner did not indicate whether Phelps or Redey were to be applied as anticipation (102) or obviousness (103) rejections. However, in reviewing Phelps or Redey, Applicants do not see where either of these references discloses or suggests a solid-state electrolyte. Thus, it is believed that neither anticipates or renders obvious the invention as claimed.

For example, in Phelps, the abstract states that the electrolyte is “non-aqueous molten salt.” There is no disclosure or suggestion in Phelps of a solid-state electrolyte, nor is it seen how Phelps could be modified to work if the electrolyte were a solid-state electrolyte. In Phelps, a metal halide (such as tin chloride) is produced in the anode compartment, and the metal halide is transported across the electrolyte, where it reacts in the cathode compartment to regenerate the pure metal (e.g., liquid tin metal), which sinks back through the liquid electrolyte to the anode compartment. See, e.g., Col. 7, lines 38-65 (describing the electrolyte as being a “non-aqueous molten salt electrolyte”), or Col. 8, line 66-Col. 9, line 49 (describing an example reaction involving tin chloride). In fact, the principle by which Phelps operates is quite similar to the discussion of Koch, above, except that a tin halide is dissolved in the molten carbonate electrolyte instead of  $\text{SnO}_2$ . Thus, like Koch, a solid-state electrolyte would prevent any transport of tin halide from occurring across the electrolyte. Accordingly, it is not seen how Phelps could anticipate or render obvious the claimed invention.

Redey describes a molten halide salt electrolyte (e.g.,  $\text{LiCl}$ ) containing dissolved a metal oxide. This system also operates similarly to the operation of Koch, including the transport of  $\text{SnO}_2$  across a liquid electrolyte. See, e.g., Col. 2, lines 59-61. In particular, in Redey, a liquid electrolyte is needed in order to transport  $\text{SnO}_2$  from the anode to the cathode, although a molten halide is used instead of a molten carbonate in Koch. See, for example, Fig. 4, or col. 2, lines 59 to col. 3, line 4, disclosing transport of  $\text{SnO}_2$  across a  $\text{LiCl}$  melt. There is no disclosure in Redey of a solid-state electrolyte, and it is not seen how such a fuel cell could function with a solid-state electrolyte, as  $\text{SnO}_2$  would be prevented from moving from the anode compartment to the cathode compartment across the electrolyte if that were the case. Accordingly, it is not seen how Redey anticipates or renders obvious the invention as claimed.

Accordingly, as both Phelps and Redey requires the use of a molten electrolyte, neither reference discloses or suggests the use of a solid-state electrolyte as is recited in the claims as currently pending; such a modification would render either of these inoperable for their respective intended purposes. Thus, it is respectfully submitted that these references are no more relevant than is Koch, and that the claims as pending are patentable over Phelps and Redey, alone or in combination with each other, Koch, and/or Horita.

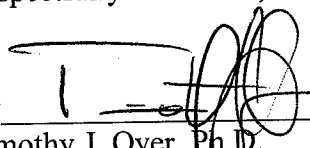
### **CONCLUSION**

In view of the foregoing, the present application is believed to be in condition for allowance. A Notice of Allowance is respectfully requested. The Examiner is requested to call the undersigned at the telephone number listed below if this communication does not place the application in condition for allowance.

If this response is not considered timely filed and if a request for an extension of time is otherwise absent, any necessary extension of time is hereby requested. If there is a fee occasioned by this response, including an extension fee, the Director is hereby authorized to charge any deficiency or credit any overpayment in the fees filed, asserted to be filed or which should have been filed herewith to our Deposit Account No. 23/2825, under Docket No. T0457.70019US00.

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Respectfully submitted,

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